CFC DATA COLLECTION DURING THE LABRADOR SEA EXPERIMENT

Dr. William M. Smethie, Jr.
Lamont-Doherty Earth Observatory
of Columbia University
PO Box 1000
Route 9W
Palisades, New York 10964
bsmeth@ldeo.columbia.edu
Voice: 914-365-8566 Fax: 914-365-8155
Award No. N000149610612

LONG TERM GOALS

The long term goals are to gain a better understanding of gas exchange between the atmosphere and the ocean during deep convection in the ocean, to establish the boundary condition for chlorofluorocarbon (CFC) input into Labrador Sea Water (LSW) (which is needed to quantitatively interpret CFC measurements made in LSW in regions away from the formation areas and will be needed to simulate CFC distributions in ocean circulation models) and to use these data in conjunction with CFC data collected on other projects to estimate the LSW formation rate and investigate temporal changes in the formation rate.

OBJECTIVES

The objective of this project was to measure the three dimensional distribution of CFC-11, CFC-12 and CFC-113 in the Labrador Sea during winter when deep convection was occurring.

APPROACH

Water samples were collected at select stations from the surface to the bottom of the Labrador Sea on Knorr cruise 147, leg 5 using 4-liter sampling bottles mounted on a rosette frame. Aliquots of 100 cc were taken from the bottles using glass syringes to avoid contact with the atmosphere and these samples were analyzed on board for CFC-11, CFC-12 and CFC-113 using electron capture gas chromatography (Smethie et al., 1988; Bullister and Weiss, 1988).

ACCOMPLISHMENTS

CFC samples were collected at 44 stations on the Knorr 147/5 cruise (Figure 1). The samples were analyzed and preliminary concentrations were calculated at sea. These preliminary concentrations indicate the data quality is very good.

SCIENTIFIC/TECHNICAL RESULTS

This project was only to collect the CFC data set in the Labrador Sea during winter when deep convection was occurring and scientific interpretation of the data is to be done in the future with another source of funding. Nevertheless, a casual examination of the data reveals some preliminary results. The basin scale distribution of CFCs can be seen in vertical sections along line 3 (Figure 2) which extends from the Labrador continental slope to the Greenland continental shelf. CFCs enter the surface ocean from the atmosphere and LSW is readily identified as a thick

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layer of high CFC water that extends down to about 2200 m in the central Labrador Sea. There are actually two layers. An upper layer with the highest CFC concentrations extends down to about 700 m in the central Labrador Sea and 1000 m in the western Labrador Sea. This is the water that has convected very recently or is undergoing convection during the cruise. It is underlain by another layer of nearly homogeneous CFC concentration which extends down to 2200 m and is LSW that formed during a previous winter when convection was stronger. Beneath the LSW is a layer of relatively low CFC concentration which is water that has entered the western basin from the eastern basin through the Gibbs Fracture Zone. This is underlain by a high CFC layer which is Denmark Strait Overflow Water (DSOW) that has recently entered the North Atlantic through Denmark Strait. The relative age of these layers is revealed by the CFC-113:CFC-11 ratio; high ratios indicate young water and low ratios older water. The highest ratios are found in the upper layer of LSW which is as expected since the water has formed during the winter of 1997. Intermediate ratios are found in the lower LSW layer and in the bottom layer of DSOW and the oldest water with the lowest ratio is the layer that originated from flow through the Gibbs Fracture Zone. Similar CFC distributions are observed along the other sections with the deepest penetration of high CFC water occurring along the western side of the Labrador Sea. Reoccupation of section 2 (see Figure 1 for location) revealed the upper CFC layer to deepen from about 900 m to about 1400 m during a 10 day period (Figure 3) indicating convection was actively occurring during the cruise.

IMPACT FOR SCIENCE AND SYSTEMS APPLICATIONS

This project provides data that is relevant to the Labrador Sea Deep Convection Experiment that is being supported by the Office of Naval Research.

TRANSITIONS

None

RELATED PROJECTS

Atlantic Climate Change Experiment (ACCE). The objective of this project is to gain a better understanding of the meridional overturning circulation of the North Atlantic Ocean. Labrador Sea Water is a major component of this circulation and the winter observations during active formation of LSW will be of great benefit to understanding measurements made in LSW downstream of its formation region as part of ACCE.

REFERENCES:

Smethie, W.M., Jr., D.W. Chipman, J.H. Swift and K.P. Koltermann, 1988, Deep-Sea Res. 35:347-369.

Bullister, J.L. and R.F. Weiss, 1988, Deep-Sea Res. 35:839-853

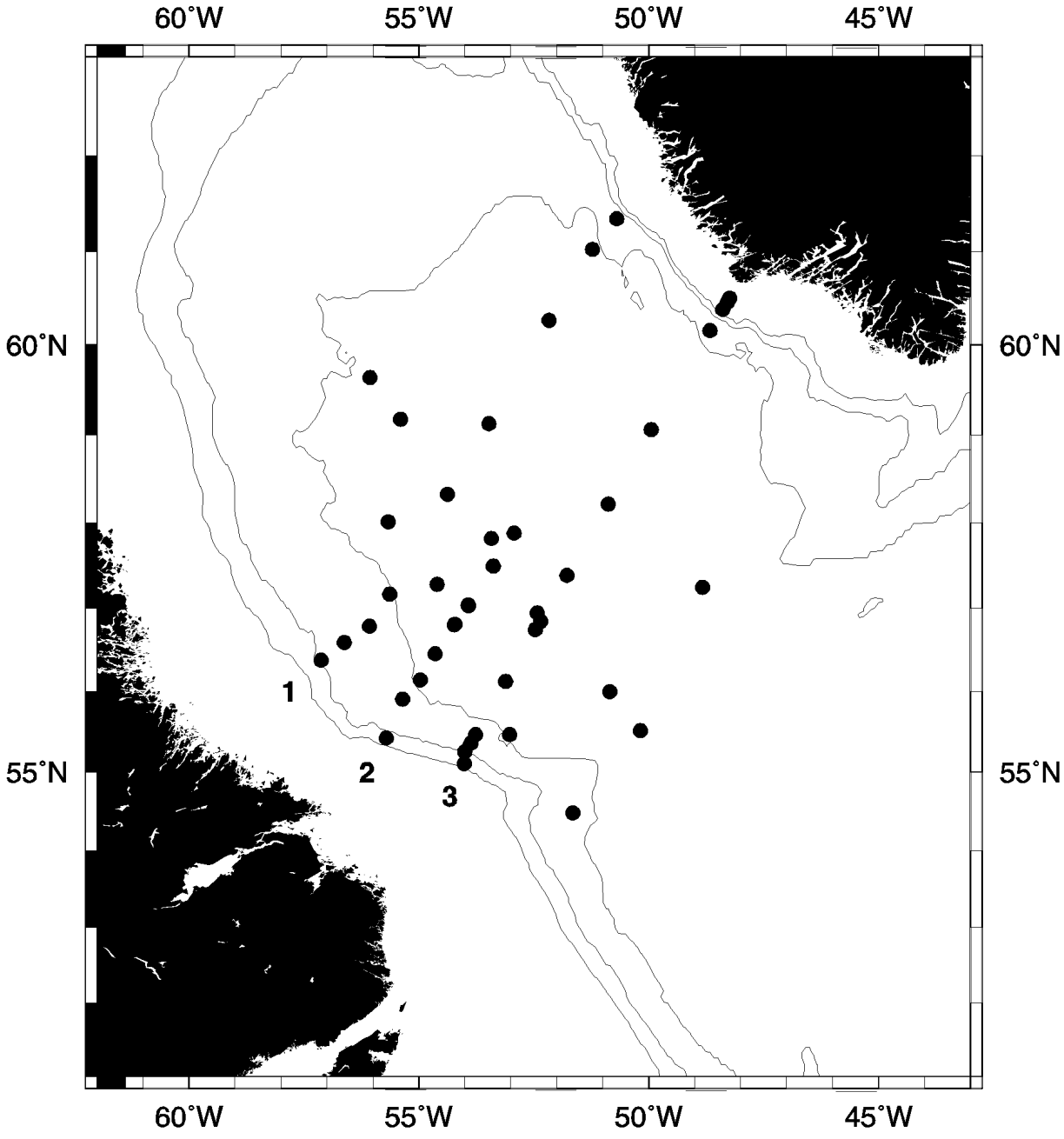

Figure 1. Location of stations sampled for CFCs on the Knorr 147/5 cruise.

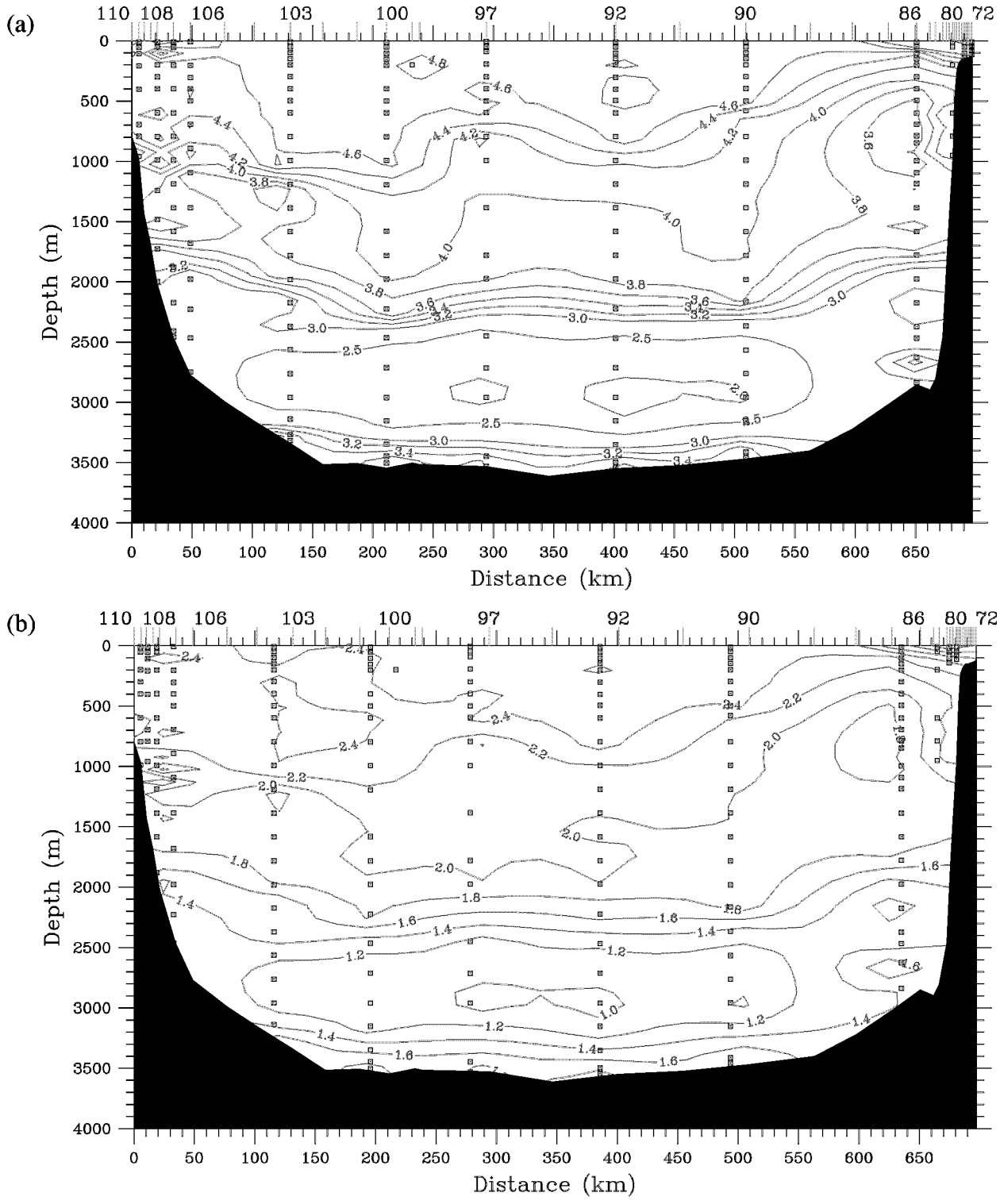

Figure 2. Vertical sections of (a) CFC–11, (b) CFC–12, (c) CFC–113, and (d) the CFC–113: CFC–11 ratio along line 3 of Knorr 147/5 cruise. See Figure 1 for location.

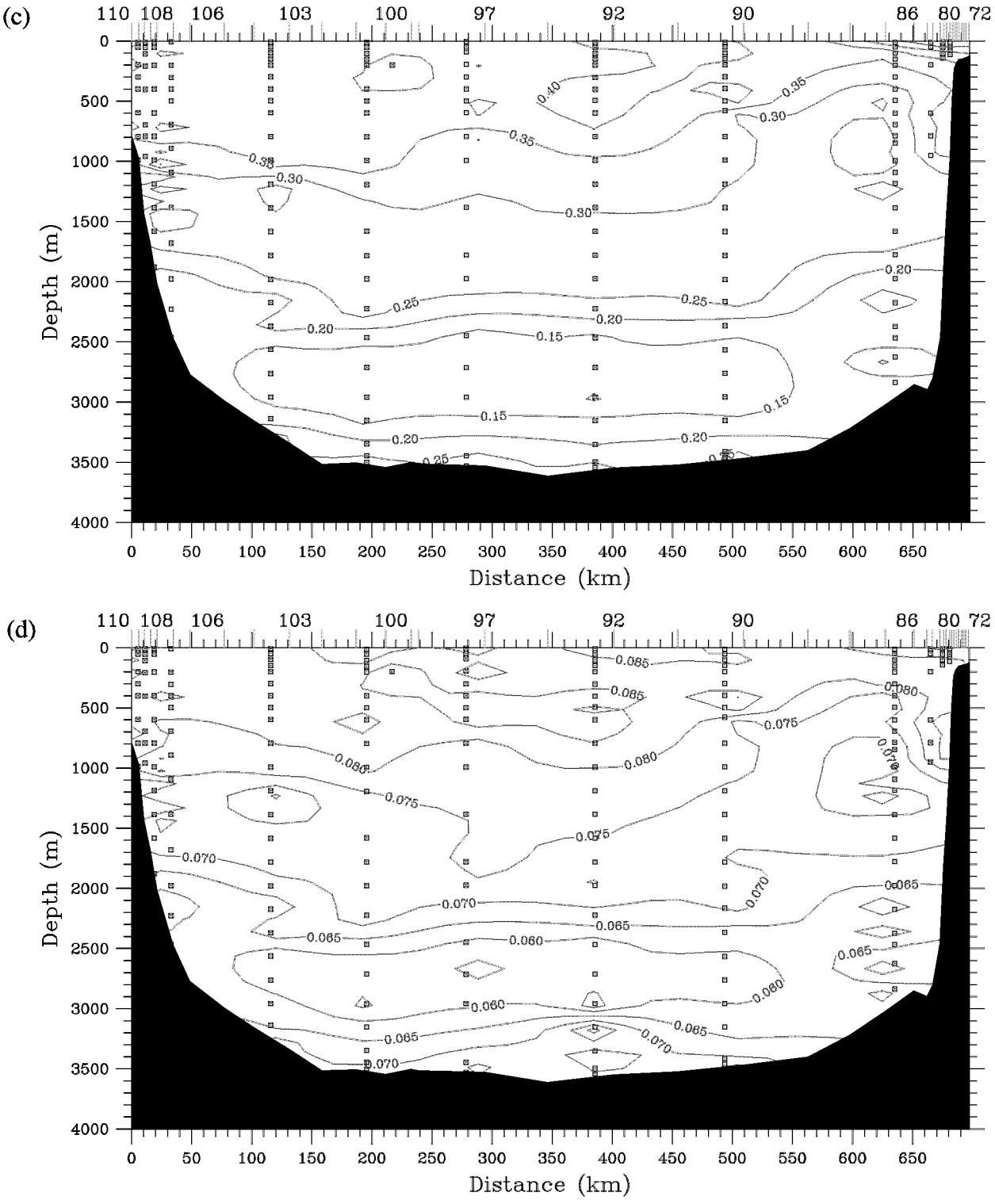

Figure 2. continued.

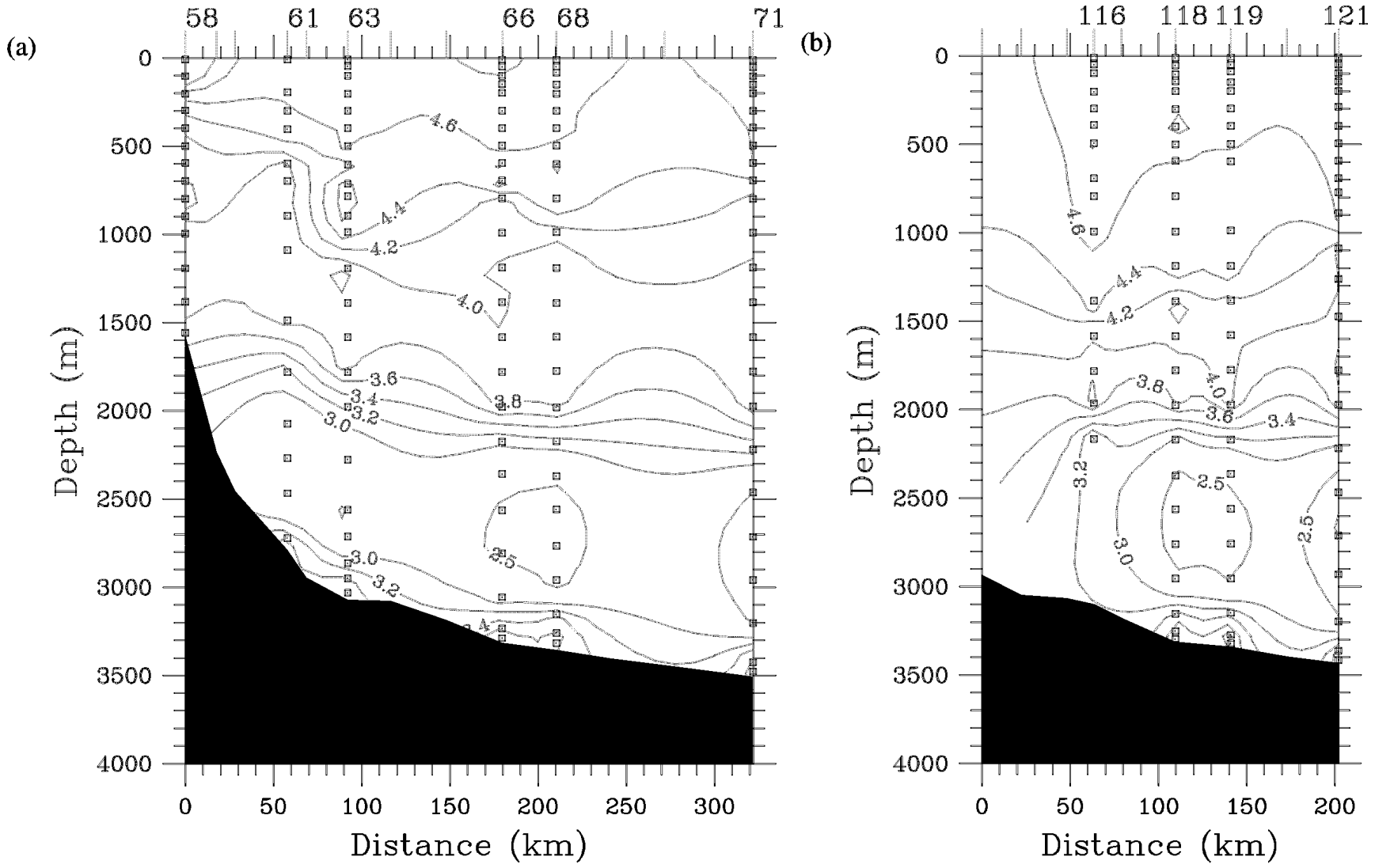

Figure 3. Vertical sections of CFC–11 along (a) line 2–1 and (b) 2–2 of the Knorr 147/5 cruise.